PHANAEUS DIFFORMIS LECONTE (COLEOPTERA: SCARABAEIDAE): CLARIFICATION OF PUBLISHED DESCRIPTIONS, NOTES ON BIOLOGY, AND DISTRIBUTION IN TEXAS

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Abstract

A clarification of published descriptions of *Phanaeus difformis* LeConte is presented. The species is found statewide and prefers, but is not restricted to, sandy soils in open pastures. It is primarily coprophagous and is attracted to swine and human feces. Field studies indicate that activities of the species (burrowing, nidification) parallel those of *P. vindex* MacLeay. In the laboratory, an average of 1 egg ball (ca. 32.4 gr each), was constructed every 8 days. Development time (egg to adult) was 6 to 12 months. Adults survived a maximum of 473 days. As determined by laboratory studies, color in this species seems to be genetically controlled.

The genus *Phanaeus* MacLeay forms an important part of the dung beetle fauna throughout much of the Western Hemisphere. The morphological study by Edmonds (1972) has provided needed information regarding this group. In Texas, the genus is represented by 4 species: *P. difformis* LeConte, *P. vindex* MacLeay, *P. triangularis* Say, and *P. torrens* LeConte. Because of the close, possibly sibling, relationship of *P. difformis* and *P. vindex* (noted by Woodruff [1973]) and since the study by Lindquist (1933) appears to be the only published biological data on *P. difformis,* extensive observations were made at several locations in the field and at the Veterinary Toxicology and Entomology Research Laboratory, College Station, Texas, in an effort to provide useful data regarding this species.

Published descriptions (LeConte 1847:86, Blanchard 1885:168, and Olsoufieff 1924:96, *P. difformis*; and Robinson 1948:302, *P. d. difformis*) of this highly variable species are inadequate for comparative purposes. LeConte's description applies only to the blue color phase of the species, and the descriptions by Blanchard, Olsoufieff, and Robinson are incomplete. Therefore, the following additions to published descriptions are offered.

Description: (Fig. 1 and 2). Rather large, robust beetles. Males average 19.4 mm in length (range 22 to 15 mm) and 11.6 mm in width (range 14 to 9 mm). Measurements of females indicate no significant differences in length or width from values given for males. Either sex may be of one of the following two color phases: shining, dark-green elytra, prothorax red dorsally shading to dark-green at the edges; or bright, deep-blue elytra, prothorax brassy or golden-green dorsally shading to deep-blue at the edges. Large series of specimens (> 100) collected at various sites indicate that ca. 1/4 of individuals in populations of this species display blue coloration. Some specimens are intermediate in color between these extremes.

Elytra in both sexes are prominently striated, the intervals reticulately punctate; intervals 1 and 2 may, or may not, be costate for varying parts of their length. Well-developed, "major" males have an erect cephalic process, or horn, arising medially on the head and curving backward over the prothorax; less well-developed, "minor" males have a much shorter horn. The disc of the pronotum in major males is flattened dorsally and is flared inward at the posterior angles; this specialization may be greatly reduced in minor males to such an extent that the pronotum has only two small protuberances. The cephalic process in females is a short, apically truncate projection and is much less variable in length than that of males. The pronotum of the female (viewed dorsally) bears a concave, transverse ridge.

Distribution in Texas: (Fig. 3). Although generally considered a western species, *P. difformis* is widely distributed throughout the state. With the exception of the lower Gulf Coast, its range overlaps that of *P. vindex* at about 98° longitude. The lack of collection records in the western part of the state (Fig. 3) is due, in part, to a lack of collecting rather than an actual absence of this species.

Field Biology: The observations upon which the following discussion is based were made during 1970-74 at sites in Gillespie, Kleberg, Robertson, and Victoria Counties. The species is diurnal and primarily coprophagous and has a marked preference for swine and human feces, a characteristic shared with many other coprids (Fincher, et al. 1970, 1971; Stewart, 1967). We routinely use swine feces as a bait in pitfall traps used for surveying populations of dung beetles. In eastern Texas where both *P. difformis* and *P. vindex* inhabit the same general area, *P. difformis* occupies areas having very sandy soils in pastures having an open, bunchgrass type of cover. *P. vindex,* on the other hand, occupies areas with heavier loam to

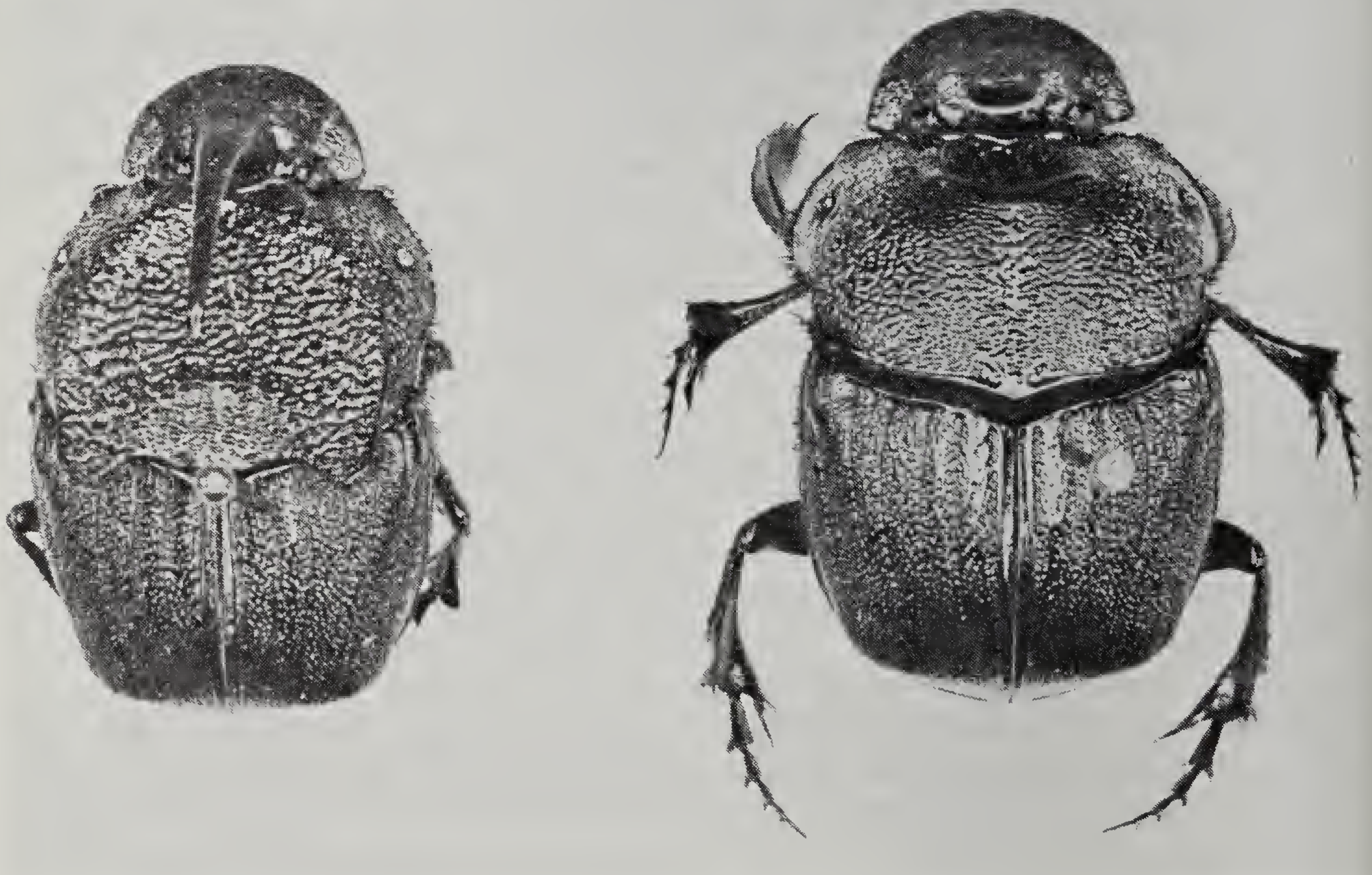

Fig. 1. *Phanaeus difformis,* dorsal views: male left, female right, ca. X 2½.

clay-loam soils supporting dense sod. Adult abundance, activity, and duration (length) of immature stages depend upon soil type, temperature, and precipitation; extremely hot, dry weather causes decreased activity, the same being true of excessively wet, cold conditions. Beetles have been observed during all months of the year; however, adult activity ceases about the end of November and begins about the beginning of April in south Texas. In more northerly areas activity ceases about a month earlier and begins about a month later. There appear to be 2 generations, or broods, each season and 3 periods of adult activity. A major peak of activity occurs about the first of April followed by a less pronounced peak in June; the 3rd period, at least as pronounced as the 1st, occurs in September or October.

Upon emergence the adults undergo a period of feeding and maturation, the "reifungsfrasse" referred to by Halffter and Matthews (1966) and others. In *P. difformis* this period lasts 2 to 3 months. Food seeking, feeding, and nidification behavior are very similar to that described for *P. vindex* by Fincher (1972) and for *P. triangularis* by Lindquist (1935). Flight is rapid, usually into the wind, and in a zig-zag pattern at a height of 1 to 1½ m above the ground. On sensing a food source, the beetle assumes a circling pattern (presumably to locate the food source) and finally alights near

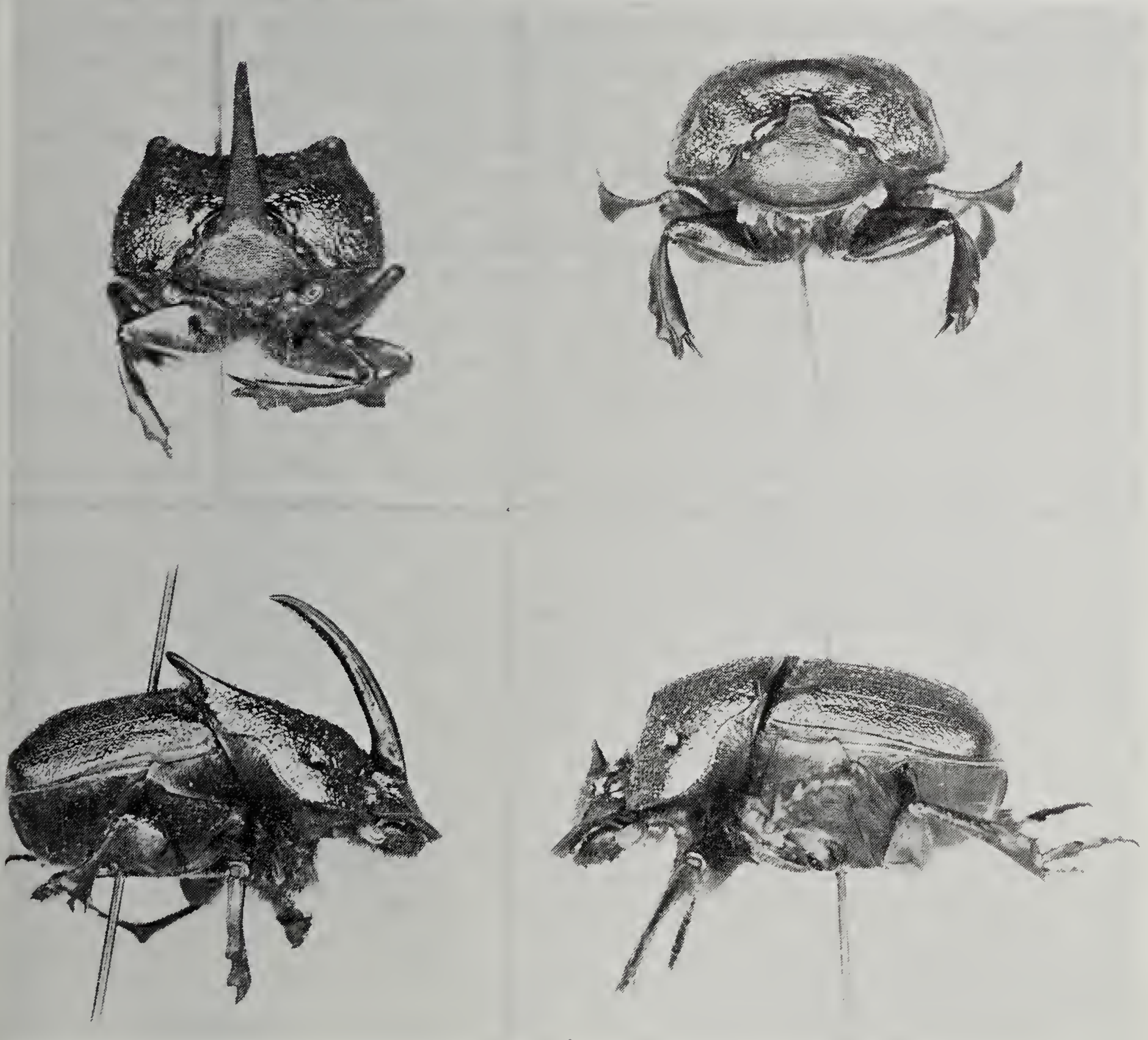

Fig. 2. *Phanaeus difformis*: Frontal view, male, upper left; frontal view, female, upper right; lateral view, male, lower left; lateral view, female, lower right, ca. X 2½.

(within 1 or 2 m) or directly on the food. The beetle immediately burrows under the food and construction of a burrow begins. Either a feeding burrow or a nidification burrow may be constructed. In each, the entrance of the burrow is either beneath or in contact with the edge of the food source. For several members of the genus, Halffter and Matthews (1966) and Halffter *et al.* (1974) reported food transportation by means of pushing or butting with the head and forelegs, followed by construction of a burrow at a distance from the food source. We have not observed this type of behavior in *P. difformis.* Feeding burrows may be constructed by either sex (only 1 beetle usually is found in these burrows) and are usually shallower and at a more oblique angle in relation to the food source than are nidification burrows. Manure is packed into these burrows in rod-like masses that may be 5 to 10 cm in length. Construction of nidification burrows may be initiated by 1 beetle of either sex and is completed as a cooperative effort by a pair (1 male, 1 female). Depending on soil type these burrows may be 15 to 30 cm in depth. At the end of the burrow, a chamber is enlarged and the egg ball is constructed by the female from manure brought by the male. Construction and shape of the egg balls are the same as has been described for numerous other members of the genus by Halffter and Matthews (1966), Fincher (1972), and Lindquist (1933, 1935). We have not observed copulation in *P. difformis* but assume that it takes place in the burrow in the presence of the egg ball. Upon completion of the egg ball, the burrow is sealed with soil and is left unattended.

The rate of development of immature stages depends upon temperature and soil moisture and thus is quite variable. However, eggs laid in the

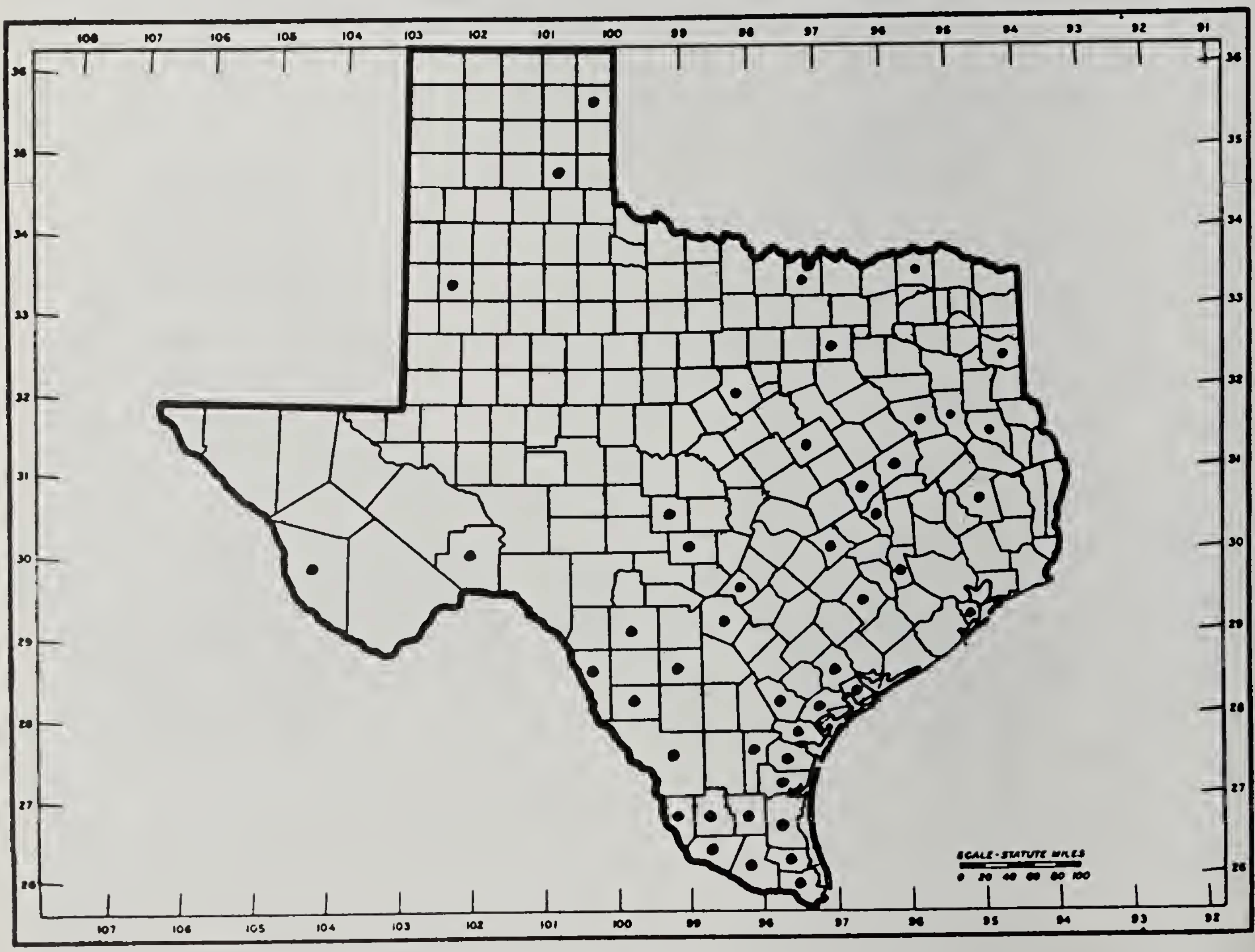

Fig. 3. Distribution of *Phanaeus difformis* in Texas.

spring usually produce adults in the fall (September or October), whereas eggs laid in the fall do not produce adults until the following spring. Overwintering occurs both in the adult and larval stage. The length of adult life can be in excess of 1 year, but it is expected that most adults do not attain this age.

Laboratory Biology: Two lines of study were pursued: (1) investigation of the life cycle of *P. difformis,* including fecundity and quantities of manure buried; and (2) attempts to clarify questions relating to color in *P. difformis.*

All laboratory observations were made in aquaria (ca. 38 L. capacity). Twelve aquaria were each filled to a depth of ca. 17.5 cm with a soil mixture consisting of 2 parts loam, 1 part sand, and 1 part peat moss. Bovine feces used for food and for nidification were obtained from animals fed a mixture of alfalfa and bermuda grass hay. Fresh feces were placed in each aquarium twice weekly. Each aquarium was completely emptied each month in order to replenish soil moisture. Temperature in the insectary was maintained at ca. 25°C. Since the insectary was illuminated by daylight entering windows, the beetles were under normal photoperiod throughout the year.

Colonization began in 1972. Because of the possible close relationship of *P. difformis* and *P. vindex,* beetles selected initially for study were obtained from areas of the state where only one species, or the other, were found. In addition, only "major" males and females were used.

The period of feeding and maturing (*reifungsfrasse*) was ca. 2 months after which the beetles, 1 male and 1 female per aquarium, constructed egg balls more or less continuously for the remainder of their life. One pair, observed for 9 months, constructed 33 egg balls (an average of 1 egg ball every 8.3 days). A 2nd pair, observed for 6 months, produced 20 egg balls (1 egg ball each 9.0 days). A 3rd pair produced 52 egg balls in a period of 13 months (1 egg ball each 7.9 days). The maximum number of egg balls produced by a pair during a 30-day period was 9 (1 egg ball each 3.3 days). The average weight of 108 egg balls was 32.4 gr (range 18.0 to 60.0 gr). The diameter of these balls averaged 37.2 mm (range 29.0 to 43.0 mm). The egg balls are pyriform, having a hard coating of soil ca. 3 to 5 mm in thickness. The eggs are laid in a small chamber at the top of the ball that was separated from the mass of manure by a thin layer of soil. Brood balls were removed from the aquaria at regular intervals and were placed in soil-filled containers until emergence. The developmental time (egg to adult) apparently is quite variable. One group of 20 egg balls formed during the same 30-day period produced the following results:

Percent of 20 brood balls	Months required for development
5	6
10	7
10	8
35	9
15	10
20	11
5	12

These data, plus many additional observations, appear to indicate that whereas the developmental period (egg to adult) may be as short as 6 months or as long as 12 months, the period of greatest emergence occurred between the 9th and 11th months. Fincher (1972) reported that the size of the emerging *P. vindex* adults apparently had no relationship to the size of the egg ball (food available to the larvae). Our observations indicate that this is also true for *P. difformis*. Adults lived for a maximum of 473 days in the insectary.

Color variation was studied by matching various combinations of green and/or blue males and females. The soil mixture used in the aquaria was the same as described above, for all matings. Also, the feces provided the beetles were obtained from one animal. Initial laboratory studies with field collected, green adults supported our observations (made in the field) that ca. 1/4 of *P. difformis* adults display the blue coloration. Of 20 adults that emerged from a group of egg balls formed in the laboratory by green parents between October 1972 and April 1973, 5 (exactly 25%) were blue. When laboratory reared blue males and females were mated, we were able to rear 24 adults from 40 brood balls. Seventeen (70.8%) of these adults were blue. Admittedly, the amount of data regarding color that we have been able to gather is small. However, we feel justified in suggesting that color in this species is controlled by genetic factors.

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CORRECT VALIDATION OF THE GENERIC NAME *ACALLEPITRIX* BECHYNÉ 1959 (CHRYSOMELIDAE: ALTICINAE)

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A nomenclaturally acceptable proposal of the neotropical genus *Acallepitrix* by Bechyné in 1959 (7) was preceded by 2 nomenclaturally unacceptable proposals of the generic name and by several new combination proposals and new species descriptions.

Both generic descriptions (2,3) published prior to 1959 are invalid because they lack the original designation of a type-species required by the International Code of Zoological Nomenclature (I.C.Z.N.) for new nominal genera proposed for more than one included species after 1930. In 1959 (7), "*Acallepitrix* n.gen." was proposed, accompanied by a type-species designation: "Generotypus: *Chalcoides erichsoni* Jac.". Specific names proposed (1,2,3,6) before 1959 in *Acallepitrix* are available even though published in combination with a generic name unavailable at the time of their description [I.C.Z.N. Art. 17(3)]. As for species (1,3,4) transferred from other genera before 1959 to the then unavailable *Acallepitrix,* we can accept Bechyné's referrals.

Two Bechyné papers published after the valid 1959 description contain differing citations to the place and date of publication of *Acallepitrix*. In 1963, Bechyné and Bechyné (11) correctly cited the 1959 description (7) of the genus. However, in 1970, Bechyné (8) cited the 1957 reference (3) as the valid description of *Acallepitrix* and designated one of the included species (*Crepidodera coracina* Boheman 1859) as type. *This was incorrect.* The 1959 description of the genus *Acallepitrix* satisfies the rules of nomenclature of the I.C.Z.N. with regard to description of a genus and designation of a type-species after 1930. *Chalcoides erichsoni* Jacoby 1902 is thus the type species of the genus *Acallepitrix,* by original designation.